

ANNEX
ENGLISH TRANSLATION OF CLAIMS
AS AMENDED IN THE INTERNATIONAL APPLICATION

NATIONAL PHASE SUBMISSION

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Claims

1. Method for controlling a valve with a valve actuating device (24), which is provided in the form of a piezo actuator, with a valve element (231), a valve body (237) and a valve seat (234), in which
 - at a predeterminable point in time (t5) the valve element (231) is moved from a position in contact with the valve seat (234) into a predetermined position away from the valve seat (234) by a discharging process of the piezo actuator,
 - the discharging process is divided into a first discharging duration (T4), during which a predetermined first amount of electrical energy is discharged from the piezo actuator, a subsequent holding time duration (T5), during which the piezo actuator is not controlled, and a subsequent second discharging duration (T6), during which a predetermined second amount of electrical energy is discharged from the piezo actuator, and
 - dependent on the waveform of a voltage at the piezo actuator or a current through the piezo actuator which is characteristic of the oscillation behavior of the piezo actuator during the holding time duration (T5), the holding time duration (T5) and/or the first discharging duration (T4) is adapted in order to ensure precise control of the valve.
2. Method for controlling a valve with a valve actuating device (24), which is provided in the form of a piezo

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actuator, with a valve element (231), a valve body (237) and a valve seat (234), in which

- at a predeterminable point in time (t1) the valve element (231) is moved from a predetermined position away from the valve seat (234) into the valve seat (234) by a charging process of the piezo actuator,
- the charging process is divided into a first charging duration (T1), during which a predetermined first amount of electrical energy is fed to the piezo actuator, a subsequent holding time duration (T2), during which the piezo actuator is not controlled, and a subsequent second charging duration (T3), during which a predetermined second amount of electrical energy is fed to the piezo actuator, and
- dependent on the waveform of a voltage at the piezo actuator or a current through the piezo actuator which is characteristic of the oscillation behavior of the piezo actuator during the holding time duration (T2), the holding time duration (T2) and/or the first charging duration (T1) is adapted in order to ensure precise control of the valve.

3. Method according to one of the preceding claims, in which the holding time duration (T2, T5) and/or the first discharging duration (T4) or the first charging duration (T1) is/are adapted dependent on the amplitude and/or the period of the waveform of the variable which is characteristic of the oscillation behavior of the piezo actuator during the holding time duration.

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4. Method according to claim 3,
in which the holding time duration (T2, T5) is adapted dependent on the period of the waveform of the variable which is characteristic of the oscillation behavior of the piezo actuator during the holding time duration.
5. Method according to one of claims 3 or 4,
in which the first discharging duration (T4) or the first charging duration (T1) is adapted dependent on the amplitude of the waveform of the variable which is characteristic of the oscillation behavior of the piezo actuator during the holding time duration (T2, T5).
6. Method according to one of claims 2 to 5 dependent on claim 2, in which the sum of the first charging duration (T1) and the holding time duration (T2) is limited to a maximum value (T_MAX), which ensures that the valve element (231) is still in contact with the valve seat (234).
7. Method according to one of claims 1 to 6, whereby the valve is part of a pump/nozzle device with
 - a pump, which has a piston (11) and a working space (13), and
 - a control unit, which comprises an outlet duct (22) that is connected hydraulically to the working space (13), the piezo actuator that forms a valve actuating device (24), and the valve, whereby the valve comprises a valve element (231), a valve body (237), a valve seat (234)

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and an auxiliary control chamber (232) which is disconnected hydraulically from the outlet duct (22) when the valve element (231) is in contact with the valve seat (234) and which otherwise is connected hydraulically to the outlet duct (22).

8. Method according to claim 7,
in which the first discharging duration (T1) is limited to a minimum value (T_MIN), which ensures that the nozzle needle (53) closes the nozzle (56).